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(58) Field of search

B2E  
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## (54) Coated friction braking element

(57) A friction braking element and a method of manufacturing such an element. A braking contact surface is applied to a non-asbestos or semi-metallic friction material by coating with polymeric material to increase the initial coefficient of friction of the element during bedding-in as compared with that which would result in the absence of the coating. The coating which may be brushed, sprayed or electro-phoretically deposited is preferably an epoxide, esterified epoxide or polybutadiene elastomer modified with phenol formaldehyde resin or resin derived from phenol and/or melamine.

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GB 2 155 809 A

## **SPECIFICATION**

## Surface treatment of friction material

5 This invention relates to the friction braking elements, particularly disc brake pads, and has particular reference to a method of manufacturing such friction elements in order to modify the initial friction characteristics of new friction elements. Some new non-asbestos or semi-metallic friction elements suffer from the disadvantage that the coefficient of friction achieved during the initial application of newly fitted  
10 brake elements is often low. This is a particularly undesirable characteristic, since the low coefficient of friction may result in increased and sometimes excessively long braking distances when the driver attempts to bring the vehicle to a halt. The coefficient of friction referred to above, and throughout this specification, is the coefficient of dynamic friction between moving contacting surfaces and is the ratio of the force acting in the direction of displacement and the normal reaction, when sliding occurs. On a  
15 braked wheel of a road vehicle the force acting in the direction of displacement is a function of the torque being applied to the wheel and the normal reaction is a function of the line pressure in the braking system.

It will be appreciated that initially, when the brake is actuated and sliding contact occurs between the rotating member in the brake assembly and the surface of the friction element, the pressure and temperature achieved on the surface of the friction element has the effect of compressing, compacting and wearing (sometimes referred to as "planishing") the material in the friction element. This planishing action is known as "bedding in", since it eliminates the high spots on the surface of the friction material and thus increases the area of contact between the rotating member in the brake assembly and the surface of the friction element. As the area of contact between the rotating member in the brake assembly and the friction element increases, the coefficient of friction between the rotating member and the surface of the friction element rises. This initial "bedding in" process is partially completed after 20 to 30 applications of the brake and usually results in a satisfactory brake performance.

The problem with low initial friction has long been recognised in vehicles fitted with new friction elements. Many car manufacturers now subject their vehicles to a dynamic friction test as the vehicle leaves the assembly line, and in some cases, the dynamic friction level achieved by such new vehicles has been unacceptably low. In these cases, it is now necessary to subject the brake to a "bedding in" process by putting the vehicles through repeated stops in order to raise the coefficient of friction to acceptable levels. It will be appreciated that this "bedding in" procedure is undesirable, since it can be a time consuming and expensive operation. An object of the present invention is to treat friction elements in such a manner that when the brake containing such friction elements is first applied, an acceptable and stable coefficient of friction is attained.

By our invention we have determined that the braking contact surface of a non-asbestos or semi-metallic friction element can be provided by a coating of a polymeric material so that the effect of such coating is to increase the initial coefficient of friction (as compared to the material without the coating) whilst the "bedding in" process is taking place. We have found that the polymeric materials which are best suited to this application are materials which are in liquid form and may be suspensions or solutions which can generally be classified as either synthetic elastomers based on a polybutadiene elastomer or epoxides. The polybutadiene elastomers are preferably modified by being blended or reacted with condensation resins of the phenol formaldehyde type derived from phenols and/or melamines. It is to be understood that the term "phenol" as used throughout this specification is a generic expression which includes substituted phenol. The epoxides can be used in isolation or esterified with unsaturated fatty acids such as linseed oil or tung oil, and the product formed is then reacted with maleic anhydride to form an acid resin.

The surface coating may be applied by a variety of means, but the preferred methods usually involve a brushing, spraying, or electro-phoretic deposition process. In an electro-phoretic coating operation, the disc brake pad to be coated forms one of the electrodes and the second electrode is made from a metal such as stainless steel. The two electrodes are immersed in a bath of the coating liquid, and a potential difference is then applied across the electrodes. The polarity is arranged so that the coating material migrates towards the friction element and is there deposited as a coating on the surface of the friction element to form a coherent film. Such films may be heat treated to provide further polymerisation or partial cross linking and hence increased stability.

When using an electro-phoretic coating operation the thickness of the coating is dependent on the initial voltage across the electrodes, the temperature of the coating liquid, and the time the disc brake pad is allowed to remain in the coating bath. It will be appreciated that as the coating thickness on the surface of the disc brake pad increases, the resistance across the coating bath electrodes also increases, so that eventually no current passes between the electrodes, and deposition of the coating material on the surface of the disc brake pad ceases. Typically, the coating deposited on the surface of a disc brake pad during an electro-phoretic coating operation is from 10 to 25 microns thick.

Preferably the present invention provides a method of treating the contact braking surface of a new non-asbestos or semi-metallic friction material containing a high proportion of metal or alloys, in order to increase the initial dynamic friction characteristics of the friction element by coating, by brushing, spraying or electro-phoretic deposition, the surface of the friction material with a liquid, suspension or solution of an epoxide such as epoxy resin, the epoxides can be used in isolation or esterified with unsaturated fatty acids such as linseed oil or tung oil and the product formed reacted with maleic anhydride to form an acid resin, such coatings may be heat treated to cross link the polymer and thus provide long term stability. As an alternative preference, the coating material for the friction material can comprise a liquid, suspension or solution of polybutadiene elastomer which has been modified by being blended or reacted 10 with resins of the phenol formaldehyde type derived from phenols and/or melamines.

The invention also includes a friction element comprising a new non-asbestos or semi-metallic friction material, having a contact braking surface coated with polymeric material. Preferably the coating is a liquid, suspension or solution of an epoxy resin which can be used in isolation or esterified with unsaturated fatty acids (such as linseed oil or tung oil and the product formed reacted with maleic anhydride to 15 form an acid resin). As an alternative preference the contact braking surface of the friction material can be coated with a liquid, suspension or solution of a polybutadiene elastomer which has been modified by being blended or reacted with resins of the phenol formaldehyde type derived from phenols and/or melamines.

Preferably therefore the present invention provides a friction braking pad and a method of manufacturing such a pad which comprises a pad of non-asbestos or semi-metallic friction material having a friction braking surface provided by a coating applied to said friction material which coating is selected from the group consisting of epoxides, esterified epoxides and polybutadiene elastomers modified with phenol 20 formaldehyde resin or resin derived from phenol and/or melamine.

Typical epoxy resins which can be used are those which are sold by ICI under the general title of Lacquer Modified Epoxy Resins and designated F972-3201 under the ICI product number. A typical phenol modified polybutadiene elastomer which can be usefully used in this application is produced and marketed by International Paints and sold under the product number 3986 P9560.

In order to compare the performance of the coated and uncoated brake pads, a series of tests were carried out on a road going vehicle. A small, British manufactured, family saloon car was adapted for the test by fitting a pressure gauge to the hydraulic pressure lines used to actuate the front disc brake calipers. Provision was also made to disconnect the rear brakes from the vehicle's braking mechanism, and an accelerometer was fitted to the vehicle to measure the deceleration achieved during the application of the front brakes. The test procedure involved fitting conventional, uncoated, semi-metallic disc pads in the front calipers, running the test vehicle at a constant speed of 30 m.p.h., on flat level ground, and then 30 measuring the deceleration achieved during applications of the front brakes. The first measurement was made by recording the maximum deceleration achieved when a hydraulic line pressure of 10 bar was applied to the front brake calipers. The hydraulic line pressure was then released, the vehicle remained in motion, and the brakes were allowed to cool for 3 minutes before they were again applied at a line pressure of 20 bar when the vehicle was travelling at a constant speed of 30 m.p.h. The maximum deceleration 35 was again noted, the hydraulic pressure was released, and the friction material was allowed to recover for a further period of 3 minutes whilst the vehicle remained in motion. This procedure was repeated with increments in line pressure of 10 bar, so that maximum decelerations were measured over six stops from 30 m.p.h. at line pressures ranging from 10 to 60 bar. Using this data it was then possible to calculate the average coefficient of friction of the material under test over the six stops. The uncoated 40 friction material was then removed from the front brake calipers of the test vehicle and replaced with a set of similar new disc brake pads which had been coated in accordance with the present invention. A series of test stops, using the procedure outlined above, were carried out in order to determine the initial average coefficient of friction of the coated disc brake pads.

The above testing procedure was carried out with three pairs of respectively uncoated and coated (in accordance with the invention) disc brake pads. In the first pair of tests a phenol modified elastomer was used as the coating material for the coated pad in that pair; in the second pair of tests an unmodified epoxy resin was used for the coated pad in that pair, and in the third test an epoxy resin esterified with linseed oil was used as the coating material for the coated pad in that pair.

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The results of these tests are shown in the table below, and the first column in the table describes the vehicle used for the test, the second column shows the initial average coefficient of friction for the untreated front disc brake pads and the third column shows the initial average coefficient of friction for front disc brake pads when coated in accordance with the present invention.

Vehicle	Initial Average Coefficient of Friction (uncoated material)	Initial Average Coefficient of Friction (coated material)	Coating Material
Small Family Saloon	0.30	0.40	Polybutadiene based resin (Phenol modified)
" "	0.31	0.44	Epoxy Resin (esterified with Linseed Oil)
" "	0.31	0.50	Epoxy Resin (Unmodified)

From the figures shown in the above table it will be seen that by coating the surface of the friction material in the manner described by the invention, the initial average coefficient of friction is increased by between 30-60% over the initial average coefficient of friction of the untreated material.

#### CLAIMS

1. A friction braking element comprising a friction material having a braking contact surface applied thereto, said contact surface being provided by a coating of polymeric material for increasing the initial coefficient of friction of said element during bedding-in of that element as compared with that which would result for said element in the absence of the coating.
2. An element as claimed in claim 1 in which the polymeric material is selected from a synthetic elastomer and an epoxide.
3. An element as claimed in claim 2 in which the synthetic elastomer comprises a polybutadiene elastomer.
4. An element as claimed in claim 3 in which the polybutadiene elastomer is modified with a resin of phenol formaldehyde type derived from at least one of phenols (as herein defined) and melamines.
5. An element as claimed in any one of claims 2 to 4 in which the epoxide is modified by esterification with unsaturated fatty acid and reacted with maleic anhydride to provide acid resin.
6. An element as claimed in any one of the preceding claims in which the coating has a thickness in the range of 10 to 25 microns.
7. An element as claimed in any one of the preceding claims in which the friction material is non-asbestos or semi-metallic.
8. An element as claimed in any one of the preceding claims in which the friction material is in the form of a disc brake pad.
9. A friction braking element which comprises a pad of non-asbestos or semi-metallic friction material having a friction braking surface provided by a coating applied to said friction material which coating is selected from the group consisting of epoxides, esterified epoxides and polybutadiene elastomers modified with phenol formaldehyde resin or resin derived from at least one of phenol (as herein defined) and melamine.
10. A friction braking element as claimed in either claim 1 or claim 9 and substantially as herein described.
11. A method of manufacturing a friction braking element which comprises applying to a friction material a coating of polymeric material to provide a braking contact surface for the element which contact surface provides a greater initial coefficient of friction during bedding-in of the element as compared with that which would be provided by the friction material in the absence of the coating.
12. A method as claimed in claim 11 in which the polymeric material is selected from a synthetic elastomer and an epoxide.
13. A method as claimed in claim 12 in which the synthetic elastomer comprises a polybutadiene elastomer.
14. A method as claimed in claim 13 which comprises modifying the polybutadiene elastomer with a resin of phenol formaldehyde type derived from at least one of phenols (as herein defined) and melamines.

15. A method as claimed in any one of claims 12 to 14 which comprises modifying the epoxide by esterifying with unsaturated fatty acid and reacting the product thereof with maleic anhydride to provide acid resin.

16. A method as claimed in any one of the claims 11 to 15 which comprises applying the coating to a thickness in the range of 10 to 25 microns.

17. A method as claimed in any one of claims 11 to 16 in which the friction material is non-asbestos or semi-metallic.

18. A method as claimed in any one of claims 11 to 17 which comprises applying the coating by brushing, spraying or electro-phoretic deposition.

19. A method as claimed in claim 18 in which the coating is applied by electro-phoretic deposition and which comprises immersing the surface of the friction material to be coated in the coating material in liquid form, directing a current through the coating material utilising the friction material as an electrode so that the polymeric material is deposited to form the braking contact surface.

20. A method as claimed in claim 19 in which the coating material is a solution or suspension of the polymeric material.

21. A method as claimed in either claim 19 or claim 20 which comprises determining the thickness of the deposited coating from the reduction in said current caused by the increasing resistance effected by the increasing thickness of that coating.

22. A method as claimed in any one of claims 11 to 21 which comprises heat treating the coating to increase the stability thereof.

23. A method of manufacturing a friction braking element which comprises applying to a pad of non-asbestos or semi-metallic friction material a friction braking surface provided by a coating on said friction material, said coating being selected from the group consisting of epoxides, esterified epoxides and polybutadiene elastomers modified with phenol formaldehyde resin or resin derived from at least one of phenol (as herein defined) and melamine.

24. A method as claimed in either claim 11 or claim 23 and substantially as herein described.

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